

Majors in the Division of Engineering and Weapons

Select one of the following to see the matrix and the elective course options for the major.

Aerospace Engineering (EAS, EASA)
Electrical Engineering (EEE)
General Engineering (EGE)
Marine Engineering (ESP)
Mechanical Engineering (EME)
Naval Architecture (ENA)
Ocean Engineering (EOE)
Systems Engineering (ESE)

Other majors and the Majors Program
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Aerospace Engineering Major

The aerospace engineering department offers one of the most exciting and challenging academic programs at the Naval Academy. The program is structured to produce naval officers who will serve in the forefront of the inception, development and employment of Navy air and space assets. The curriculum provides a background in engineering fundamentals through courses in chemistry, physics, mathematics, engineering mechanics, thermodynamics and electrical engineering. With these subjects as a base, students undertake aerospace engineering topics including aerodynamics, propulsion and aerospace structures. The major is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology.

In the area of aeronautics, students extend their study of aerodynamics, flight structures and flight mechanics. The astronautics track allows students to study astrodynamics, satellite attitude dynamics and control, and the space environment. Both tracks conclude with a design course, which allows midshipmen to apply their engineering knowledge to the design of an aero or space flight vehicle. Both tracks also involve thorough laboratory experimentation. The Naval Academy's aerospace laboratory facilities are some of the most advanced and extensive in the country. These facilities include structures, propulsion and rotor labs; variable stability aircraft simulator; spacecraft tracking and experimentation facilities; and various wind tunnels with flow velocities ranging from subsonic to supersonic.

The aerospace engineering major is not required for midshipmen who just want to fly. The Naval Academy prepares all midshipmen to become professional officers in the naval service, and upon commissioning they can choose from exciting careers in the aviation, surface or subsurface communities or service in the Marine Corps.

Graduates from the aerospace engineering major are also fully prepared to undertake postgraduate education programs in engineering disciplines either at the Naval Postgraduate School or any other academic institution. Naval officers with advanced degrees in the aero/space areas may be assigned to billets involved with the research, development, test and evaluation of Navy aircraft or spacecraft projects. Locations for these challenging technical billets include the Naval Air Systems Command, Naval Research Laboratory, Test Pilot School, the Navy's Space Command, the Unified Space Command, the Navy Space Support Activity and perhaps as a naval astronaut with the National Aeronautics and Space Administration.

Curriculum Requirements (in addition to the requirements of plebe year)

Professional: NE203, NL302, NL400, NS310, NS40X;

Mathematics: SM212, SM221;

Science: SP211, SP212;

Humanities: HH205, HH206, two electives including one at the 300/400 level;

Engineering: EE331, EE332, EM211, EM214, EM217, EM232, EM319, ES300, ES410;

Major: Aeronautics Track - EA202, EA301, EA303, EA304, EA307, EA322, EA332, EA401, EA413, EA429, EA440, plus two major electives; Astronautics Track - EA205, EA305, EA307, EA322, EA362, EA364, EA365, EA461, EA465, EA466, EA467, EA470, plus one major elective.

Class of 2000 - Aerospace Engineering (Aeronautics) Major - EAS					
3/c Fall	3/c Spring	2/c Fall	2/c Spring	1/c Fall	1/c Spring
NN200 3-2-4 Navigation		NS310 1-2-2 Tactics	NL302 2-0-2 Leadership III	NL400 2-0-2 Law for the Junior Officer	NS401/2/3/4 1-2-2 Junior Officer Practicum
SP211 3-2-4 General Physics I	SP212 3-2-4 General Physics II			ES300 3-0-3 Naval Weapons Systems	
SM221 4-0-4 Calculus III with Vector Fields	SM212 4-0-4 Differential Equations		EE331 3-2-4 Electrical Engineering I	EE332 3-2-4 Electrical Engineering II	ES410 3-2-4 Control Systems
NE203 3-0-3 Ethics and Moral Reasoning		HUM/SS Elective 3-0-3			
	HH205 3-0-3 Western Civilization I	HH206 3-0-3 Western Civilization II			HUM/SS Elective 3-0-3
EM211 3-0-3 Statics	EM232 3-0-3 Dynamics	EM217 3-2-4 Strength of Materials			
	EM214 2-2-3 Elements of Materials Science	EM319 3-0-3 Engineering Thermodynamics	EA307 3-0-3 Engineering Analysis		
	EA202 2-2-3 Principles of Flight	EA301 3-0-3 Aerodynamics I	EA304 3-0-3 Aerodynamics II	EA401 3-0-3 Applied Aerospace and Design	EA440 1-4-3 Aerospace Vehicle Design
		EA303 1-2-2 Wind Tunnel	EA322 2-2-3 Structures I	EA413 3-0-3 Stability and Control	Major Elective 3-0-3
			EA332 2-2-3 Gas Dynamics	EA429 2-2-3 Flight Propulsion	Major Elective 3-0-3
18	20	20	18	18	18

AEROSPACE ENGINEERING MAJOR
AERONAUTICS TRACK

CLASS OF 2000

Required Aerospace Courses:

EA202	Principles of Flight	2-2-3
EA301	Aerodynamics I	3-0-3
EA303	Wind Tunnel	1-2-2
EA304	Aerodynamics II	3-0-3
EA307	Engineering Analysis	3-0-3
EA322	Aerospace Structures I	2-2-3
EA332	Gas Dynamics	2-2-3
EA401	Applied Aero and Design	3-0-3
EA413	Stability and Control	3-0-3
EA429	Flight Propulsion	2-2-3
EA440	Aerospace Vehicle Design	1-4-3

Major Electives:

EA421	Structures II	3-0-3
EA424	Structural Dynamics	3-0-3
EA425	Viscous Flow	3-0-3
EA427	Aerodynamics III	3-0-3
EA428	Computational Aerodynamics	3-0-3
EA430	Propulsion II	3-0-3
EA435	Aerodynamics of V/STOL Aircraft	3-0-3
EA439	Special Design	1-4-3
EA450	Computer Aided Design	2-2-3
EA482	Aerospace Seminar	1-0-1
EA49X	Research and Special Projects	
EM411	Heat Transfer	3-0-3

NOTES: All electives require departmental approval.

Class of 2000 - Aerospace Engineering (Astronautics) Major - EASA					
3/c Fall	3/c Spring	2/c Fall	2/c Spring	1/c Fall	1/c Spring
NN200 3-2-4 Navigation	NE203 3-0-3 Ethics and Moral Reasoning	NS310 1-2-2 Tactics	NL302 2-0-2 Leadership III	NL400 2-0-2 Law for the Junior Officer	NS401/2/3/4 1-2-2 Junior Officer Practicum
SP211 3-2-4 General Physics I	SP212 3-2-4 General Physics II			ES300 3-0-3 Naval Weapons Systems	
SM221 4-0-4 Calculus III with Vector Fields	SM212 4-0-4 Differential Equations		EE331 3-2-4 Electrical Engineering I	EE332 3-2-4 Electrical Engineering II	ES410 3-2-4 Control Systems
HH205 3-0-3 Western Civilization I	HH206 3-0-3 Western Civilization II	HUM/SS Elective 3-0-3			HUM/SS Elective 3-0-3
EM211 3-0-3 Statics	EM232 3-0-3 Dynamics	EM217 3-2-4 Strength of Materials			
	EM214 2-2-3 Elements of Materials Science	EM319 3-0-3 Engineering Thermodynamics	EA307 3-0-3 Engineering Analysis		
EA205 2-2-3 Principles of Aeronautics and Astronautics		EA305 2-2-3 Fluid and Gas Dynamics	EA322 2-2-3 Structures I	EA461 3-0-3 Space Environment	EA466 3-0-3 Spacecraft Thermal Control
		EA362 3-0-3 Astrodynamics I	EA364 3-0-3 Attitude Dynamics and Control	EA465 3-0-3 Space Power and Communications	EA470 1-4-3 Spacecraft Vehicle Design
			EA365 2-2-3 Rocket Propulsion	EA467 0-4-2 Spacecraft Systems Laboratory	Major Elective 3-0-3
21	20	18	18	17	18

Major Credits: 54

Total Credits: 146

Last modified: 3/20/97

AEROSPACE ENGINEERING MAJOR
ASTRONAUTICS TRACK

CLASS OF 2000

Required Aerospace Courses:

EA205	Principles of Aeronautics & Astronautics	2-2-3
EA305	Fluid/Gas Dynamics	2-2-3
EA307	Engineering Analysis	3-0-3
EA322	Aerospace Structures I	2-2-3
EA362	Astrodynamics I	3-0-3
EA364	Spacecraft Attitude Dynamics	3-0-3
EA365	Space Propulsion	2-2-3
EA461	Space Environment	3-0-3
EA465	Space Power/Communications	3-0-3
EA466	Spacecraft Thermal Control	3-0-3
EA467	Spacecraft Systems Laboratory	0-4-2
EA470	Spacecraft Design	1-4-3

Major Electives:

EA421	Structures II	3-0-3
EA424	Structural Dynamics	3-0-3
EA430	Propulsion II	3-0-3
EA439	Special Design	1-4-3
EA450	Computer Aided Design	2-2-3
EA462	Astrodynamics II	3-0-3
EA482	Aerospace Seminar	1-0-1
EA49X	Research and Special Projects	
EM411	Heat Transfer	3-0-3

NOTES: All electives require departmental approval.

Electrical Engineering Major

The Electrical Engineering Department offers one of the cornerstone disciplines that will shape many aspects of the Navy for the foreseeable future. The major offers a solid grounding in the fundamentals of electrical engineering, as well as the opportunity to investigate introductory undergraduate concepts of advanced specialties in communication systems, digital computer systems, fiber optic systems, microwaves, and instrumentation. The Navy needs officers trained in these engineering concepts to lead in the development, integration, and operation of advanced systems. The electrical engineering major is accredited by the Accreditation Board for Engineering and Technology (ABET) and leads to a bachelor of science in electrical engineering.

Electrical engineering majors apply classroom concepts in the laboratory throughout the program. The Department has extensive well-equipped laboratories to provide excellent hands-on support of every course in the EE major. Dedicated laboratories support EE courses in fiber optics, electronics, microwaves, digital and analog communications, operation and integration of digital hardware and software, electro-mechanical energy conversion, and advanced electrical engineering project design. The Department emphasizes individual lab station learning to ensure thorough understanding of required skills as well as the team approach to solving design problems. EE labs are constantly updated with leading edge technology.

The electrical engineering capstone senior design laboratory sequence (EE411 and EE412) integrates all required critical aspects of complete significant professional design. Two midshipmen per year are awarded the EE Department's Steinmetz Prize for innovative work in this laboratory course sequence. The Captain Boyd R. Alexander Prize in electrical engineering is presented during Commissioning Week to the outstanding graduate in the EE major.

Graduates of the electrical engineering program are very well prepared for any of the many jobs they may be assigned in the fleet. The major also provides an excellent fundamental background and foundation for continued, more specialized study in electrical engineering at the graduate level on active duty after commissioning at the Naval Postgraduate School or any other academic institution.

Curriculum Requirements (in addition to the requirements of plebe year)

Professional: NE203, NL302, NL400, NN200, NS310, NS40X;

Mathematics: SM221, SM212, SM313;

Science: SP211X, SP212X;

Humanities: HH205, HH206, and two elective courses including one at the 300/400 level;

Engineering: EM211, EM318, EM319, ES300, ES410;

Major: EE221, EE226, EE242, EE322, EE341, EE342, EE362, EE372, EE411, EE412, EE421, plus two major electives.

Class of 2000 - Electrical Engineering Major - EEE					
3/c Fall	3/c Spring	2/c Fall	2/c Spring	1/c Fall	1/c Spring
NN200 3-2-4 Navigation	NE203 3-0-3 Ethics and Moral Reasoning	NS310 1-2-2 Tactics	NL302 2-0-2 Leadership III	NL400 2-0-2 Law for the Junior Officer	NS401/2/3/4 1-2-2 Junior Officer Practicum
SP211X 3-2-4 General Physics I	SP212X 3-2-4 General Physics II		ES300 3-0-3 Naval Weapons Systems	ES410 3-2-4 Control Systems	
SM221 4-0-4 Calculus III with Vector Fields	SM212 4-0-4 Differential Equations				
		HH205 3-0-3 Western Civilization I	HH206 3-0-3 Western Civilization II	HUM/SS Elective 3-0-3	HUM/SS Elective 3-0-3
EM211 3-0-3 Statics		SM313 3-0-3 Engineering Math III		EM318 3-0-3 Applied Fluid Mechanics	
*EE221 3-2-4 Intro to Electrical Engineering	*EE226 3-2-4 Circuit Analysis I	EE323 3-2-4 Signals and Systems	EE362 3-2-4 Electronic Communications	EE411 1-2-2 Electrical Engineering Design I	EE412 2-2-3 Electrical Engineering Design II
	EE242 3-2-4 Digital Systems	*EE341 3-2-4 Electronics I	EE342 3-2-4 Electronics II		EE421 3-2-4 Energy Conversion
		EM319 3-0-3 Engineering Thermodynamics	EE372 2-2-3 Fields	EE Elective 3/4	EE Elective 3
19	19	19	19	16/17	15

* Satisfies core requirements.

Major Credits: 54/55

Total Credits: 141/142

Last modified: 3/27/97

ELECTRICAL ENGINEERING MAJOR

CLASS OF 2000

Required Courses:

EE221	Introduction to Electrical Engineering	3-2-4
EE226	Circuit Analysis	3-2-4
EE242	Digital Systems	3-2-4
EE322	Signals and Systems	2-2-3
EE341	Electronics I	3-2-4
EE342	Electronics II	3-2-4
EE362	Electronic Communications	3-2-4
EE372	Fields	2-2-3
EE411	Electrical Engr. Design I	1-2-2
EE412	Electrical Engr. Design II	2-2-3
EE421	Energy Conversion	3-2-4
EM318	Applied Fluid Mechanics	3-0-3
EM319	Engineering Thermodynamics	3-0-3
ES410	Control Systems	3-2-4
SM313	Engineering Mathematics III	3-0-3

Major Electives:

EE424	Electronic Instr. & Measurement	2-4-4
EE431	Communications Theory I	3-2-4
EE432	Communications Theory II	3-2-4
EE451	Electrical Properties of Semiconductors	3-0-3
EE452	Semiconductor Electronics	3-2-4
EE461	Microcomputer-Based Digital Design	3-2-4
EE462	Microcomputer Interfacing	2-4-4
EE471	Microwave Systems	3-2-4
EE472	Fiber Optic Communications	3-2-4
ES409	Modern Control Systems	3-0-3
ES414	Sampled Data & Digital Control Systems	2-2-3
ES415	Nonlinear Control Systems	2-2-3
ES416	Advanced Control Systems	3-0-3

A minimum of two major electives is required.

NOTES:

1. Midshipmen should consult with their academic advisers to ensure selection of courses that satisfy the ABET design criteria.
2. Midshipmen having the time (usually allowed by validation) are strongly encouraged to complete additional electives in order to strengthen their major. Well qualified students may benefit from EE49x research courses.
3. Before scheduling any ES major electives, midshipmen should obtain permission from the Chairs of the Weapons and Systems Engineering and Electrical Engineering Departments.

General Engineering Major

The general engineering major provides a basic technical education in mathematics, science, engineering and naval professional subjects. It offers a broad engineering background for future naval service and for additional advanced technical training and education. Midshipmen completing the general engineering major receive a designated bachelor of science degree.

Curriculum Requirements (in addition to the requirements of plebe year)

Professional: NE203, NL302, NL400, NN200, NS310, NS40X;

Mathematics: SM212, SM221, SM230;

Science: SP211, SP212;

Humanities: HH205, HH206 plus two electives including one at the 300/400 level;

Engineering: EE300, EN200, ES310, ES420;

Major: EE313, EM211, EM232, EM214, EM318, EM319, plus eight major electives and one free elective.

Class of 2000 - General Engineering Major - EGE					
3/c Fall	3/c Spring	2/c Fall	2/c Spring	1/c Fall	1/c Spring
NN200 3-2-4 Navigation	NE203 3-0-3 Ethics and Moral Reasoning	NS310 1-2-2 Tactics	NL302 2-0-2 Leadership III	NL400 2-0-2 Law for the Junior Officer	NS401/2/3/4 1-2-2 Junior Officer Practicum
SP211 3-2-4 General Physics I	SP212 3-2-4 General Physics II				
SM221 4-0-4 Calculus III with Vector Fields	SM230 3-0-3 Probability with Naval Applications	EE300 3-2-4 Intro Fundamental Electrical Technology	ES310 3-2-4 Intro to Weapons Systems Engineering	ES420 3-2-4 Weapons Systems Engineering	
	3-0-3 HUM/SS Elective	3-0-3 Free Elective			
HH205 3-0-3 Western Civilization I	HH206 3-0-3 Western Civilization II			3-0-3 HUM/SS Elective	
		SM212 4-0-4 Differential Equations	3-0-3 Math/Science/ Engineering Elective		3-0-3 Math/Science/ Engineering Elective
EM211 3-0-3 Statics	EM232 3-0-3 Dynamics		3-0-3 Technical Elective	3-0-3 Technical Elective	EE313 3-2-4 Logic Design
		EM319 3-0-3 Engineering Thermodynamics	EM318 3-0-3 Applied Fluid Dynamics	300/400 3-0-3 Engineering Elective	300/400 3-0-3 Engineering Elective
		EN200 3-2-4 Naval Engineering I	EM214 2-2-3 Elements of Materials Science	300/400 3-0-3 Engineering Elective	300/400 3-0-3 Engineering Elective
18	19	20	18	18	15

Major Credits: 40

Total Credits: 142

Last modified: 3/6/97

GENERAL ENGINEERING MAJOR

CLASS OF 2000

Suggested Engineering Electives

EA322	Aerospace Structures I	2-2-3
EA362	Astrodynamics I	3-0-3
EM320	Applied Thermodynamics	2-2-3
EM423	Mechanical Vibrations	3-0-3
EM453	Matls: Processing and Fabrication	3-0-3
EN361	Marine Power Systems	2-2-3
EN362	Reactor Physics I	3-0-3
EN441	Ocean Engineering Structures	3-0-3
EN450	Engineering Economic Analysis	3-0-3
EN470	Life Support Systems	3-0-3
ES430	Introduction to Computer Engineering	2-2-3
ES450	Introduction to Robotic Systems	2-2-3

Suggested Mathematics/Science/Engineering Electives

EA202	Principles of Flight	2-2-3
SI204	Introduction to Computer Science	3-2-4
SI250	Information Systems for JOs	2-2-3
SO221	Introductory Oceanography	3-0-3
SM261	Matrix Theory	3-0-3

Suggested Technical Electives

EM217	Strength of Materials	3-2-4
SA302	Analysis of Naval Tactics	3-2-4
SM311	Engineering Mathematics I	3-0-3
SM312	Engineering Mathematics II	3-0-3
SO342	Introduction to Meteorology	3-2-4
SP301	Modern Physics	3-0-3
SP411	Underwater Acoustics and Sonar	3-0-3

Engineering Electives must be chosen from among 300 or 400 level courses offered by the Division of Engineering and Weapons. Mathematics/Science/Engineering Electives are any 3 or 4 credit courses in the Division of Engineering and Weapons or the Division of Mathematics and Science. A Technical Elective is any engineering course or, with adviser approval, any upper level (300/400) mathematics or science course. Selection of all 4 Engineering Electives from the same discipline will allow, with departmental approval, transcript designation of the "area of concentration."

Marine Engineering Major

The marine engineering major is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology. The major is concerned with the analysis and design of energy systems. Energy - its shortage, its efficient use and pollution caused by its use - are problems tackled by the marine engineer. The marine engineer's task is to develop propulsion plants to move ships at optimum operational speeds while using as little fuel as possible. Improvements in efficiency of all types of power plants are needed - conventional steam, gas turbine, diesel and nuclear. Today's marine engineers are also engaged in developing new fuels and technologies. They are developing lightweight reduction gears and super conductive motors and generators. They are studying the feasibility of using closed-cycle helium turbines for ship propulsion plants.

Midshipmen majoring in marine engineering develop a sound understanding of problems involved in analyzing and designing power systems for use in the ocean environment; of the principles of fluid dynamics, heat transfer and reactor physics; and of the techniques and methods utilized in power plant design and analysis. They have ample opportunity to broaden this knowledge through participation in individual and group design projects under the direction of faculty members representing a wide range of technical backgrounds and practical experience.

Among the outstanding laboratory facilities available to marine engineers in Rickover Hall are a steam power plant, gas turbines and diesel engines, a sub-critical nuclear reactor, a high-energy neutron generator and a fully equipped nuclear laboratory, and a fully-equipped nuclear laboratory. A dedicated faculty and technical staff complement these facilities to provide one of the best programs in conventional and nuclear propulsion plants in the country. A bachelor of science degree in marine engineering is awarded.

Curriculum Requirements (in addition to the requirements of plebe year)

Professional: NE203, NL302, NL400, NN200, NS310, NS40X;

Mathematics: SM212, SM221;

Science: SP211, SP212;

Humanities: HH205, HH206 and two electives including one at the 300/400 level;

Engineering: EE331, EE332, EM211, EM217, EM232, EM319, EM324, ES300, ES410;

Major: EN245, EN361, EN362, EN366, EN380, EN443, EN460, EN467, plus three major electives.

Class of 2000 - Marine Engineering Major - ESP					
3/c Fall	3/c Spring	2/c Fall	2/c Spring	1/c Fall	1/c Spring
NN200 3-2-4 Navigation		NS310 1-2-2 Tactics	NL302 2-0-2 Leadership III		NS401/2/3/4 1-2-2 Junior Officer Practicum
SP211 3-2-4 General Physics I	SP212 3-2-4 General Physics II				NL400 2-0-2 Law for the Junior Officer
SM221 4-0-4 Calculus III with Vector Fields	SM212 4-0-4 Differential Equations	EE331 3-2-4 Electrical Engineering I	EE332 3-2-4 Electrical Engineering II	ES300 3-0-3 Naval Weapons Systems	ES410 3-2-4 Control Systems
NE203 3-0-3 Ethics and Moral Reasoning	HUM/SS Elective 3-0-3				
	HH205 3-0-3 Western Civilization I	HH206 3-0-3 Western Civilization II			HUM/SS Elective 3-0-3
EM211 3-0-3 Statics	EM232 3-0-3 Dynamics	EM217 3-2-4 Strength of Materials	EN366 3-0-3 Computer Methods in Power Engineering	EN380 3-0-3 Naval Materials Science and Engineering	
		EM319 3-0-3 Engineering Thermodynamics	EM324 3-2-4 Fluid Dynamics	EN467 3-0-3 Thermal Engineering	
	EN245 2-2-3 Principles of Ocean Systems Engineering		EN361 2-2-3 Marine Power Systems	EN443 2-2-3 Marine Engineering Design I	EN460 2-2-3 Marine Engineering Design II
			EN362 3-0-3 Reactor Physics I	Major Elective 3-0-3	
				Major Elective 3-0-3	Major Elective 3-0-3
18	20	16	19	18	17

Major Credits: 50

Total Credits: 142

Last modified: 3/6/97

MARINE ENGINEERING MAJOR

CLASS OF 2000

Required Courses:

EM211	Statics	3-0-3
EM232	Dynamics	3-0-3
EM217	Strength of Materials	3-2-4
EN245	Principles of Ocean Systems Engineering	2-2-3
EM319	Engineering Thermodynamics	3-0-3
EM324	Fluid Dynamics	3-2-4
EN361	Marine Power Systems	2-2-3
EN362	Reactor Physics I	3-0-3
EN366	Computer Methods in Power Engineering	3-0-3
ES410	Control Systems	3-2-4
EN443	Marine Engr. Design I	2-2-3
EN460	Marine Engr. Design II	2-2-3
EN467	Thermal Engineering	3-0-3

Major Electives:

Conventional Power Track

EM461	Engines: Principles, Design and Applications	2-2-3
EN353	Resistance and Propulsion	3-2-4
EN472	Gas Turbines: Design and Analysis	3-0-3
EN477	Underwater Power Systems	3-0-3

Electrical Power Track

EE421	Electrical Energy Conversion	2-2-3
EN477	Undersea Power Systems	3-0-3

Nuclear Power Track

EN463	Reactor Physics II	2-2-3
EN468	Nuclear Energy Conversion	3-0-3

Other electives in the Divisions of Engineering and Weapons or Mathematics and Science may be allowed upon approval of the Department Chair.

Mechanical Engineering Major

The mechanical engineering major, accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology, offers one of the most diversified engineering programs available at the Naval Academy. In addition to an education in mechanical engineering, the program prepares its graduates to assume responsibilities in any of the warfare specialties of the U.S. Navy and U.S. Marine Corps. Immediate graduates will be in positions of responsibility involving the operation and maintenance of high technology weapons systems. As officers progress through their career, many will assume positions of responsibility as managers of weapons systems development and procurement. This dictates a program that emphasizes a broad spectrum of undergraduate studies. The program thus includes study in solid and fluid mechanics, dynamics, thermodynamics and energy systems, materials engineering and a significant emphasis on electrical engineering and control systems fundamentals.

Though graduates, as commissioned officers, are not designers, the program takes seriously the need to develop in its graduates a sound understanding of the design process and its importance in the success of engineering activity. Design education in the program is focused through a series of four sequential courses, beginning in the first semester of the junior year (EM375, EM371, EM477, EM472), which are the design backbone. In each semester, other courses which are more often identified with the analysis of engineering science provide direct support to the design backbone through problems and small projects that build on concepts and tools developed in the design backbone. In this manner, the subject of design and design tools are woven into the program as integrated engineering activity.

A Navy or Marine Corps officer with a bachelor's degree in mechanical engineering is well equipped for a wide variety of career assignments both ashore and afloat. Operational sea billets in surface ships, submarines and aircraft squadrons provide many opportunities for a mechanical engineer to develop practical experience in a warfare or engineering specialty area while contributing to fleet engineering and material readiness. The operational environment enables a junior officer to rapidly develop sound leadership and managerial abilities while refining mechanical engineering capabilities acquired at the Naval Academy.

Ashore, the mechanical engineer has a wide range of opportunities in subspecialty billets with naval applications. These include such areas as ship and aircraft design, propulsion systems, environmental systems, advanced engineering education, major project management and weapons systems acquisition. There is an abundant and continuing need for mechanical engineers throughout today's naval service.

Curriculum Requirements (in addition to the requirements of plebe year)

Professional: NE203, NL302, NL400, NN200, NS310, NS40X;

Mathematics: SM212, SM221;

Science: SP211 and SP212;

Humanities: HH205, HH206, and two electives including one at the 300/400 level;

Engineering: EE331, EE332, EM211, EM217, EM232, EM313, EM319, EM324, ES300, ES410;

Major: EM320, EM371, EM375, EM415, EM472, EM477, plus three major electives, one free elective.

Class of 2000 - Mechanical Engineering Major - EME					
3/c Fall	3/c Spring	2/c Fall	2/c Spring	1/c Fall	1/c Spring
NN200 3-2-4 Navigation	NE203 3-0-3 Ethics and Moral Reasoning	NS310 1-2-2 Tactics	NL302 2-0-2 Leadership III		NS401/2/3/4 1-2-2 Junior Officer Practicum
SP211 3-2-4 General Physics I	SP212 3-2-4 General Physics II	ES300 3-0-3 Naval Weapons Systems			NL400 2-0-2 Law for the Junior Officer
SM221 4-0-4 Calculus III with Vector Fluids	SM212M 4-0-4 Differential Equations	EE331 3-2-4 Electrical Engineering I	EE332 3-2-4 Electrical Engineering II	ES410 3-2-4 Control Systems	
HH205 3-0-3 Western Civilization I	HH206 3-0-3 Western Civilization II		3-0-3 HUM/SS Elective		3-0-3 HUM/SS Elective
				3-0-3 Free Elective	
EM211 3-0-3 Statics	EM232 3-0-3 Dynamics	EM319 3-0-3 Engineering Thermodynamics	EM324 3-2-4 Fluid Dynamics		
	EM217 3-2-4 Strength of Materials	EM313 3-2-4 Materials Science	EM320 2-2-3 Applied Thermodynamics	EM415 3-2-4 Heat Transfer	EM472 2-2-3 Mechanical Design
		EM375 2-2-3 Mechanical Engineering Experimentation	EM371 2-2-3 Intro to Design	3-0-3 Major Elective	3-0-3 Major Elective
				EM477 2-2-3 Computer Aided Design	3-0-3 Major Elective
18	21	19	19	17	16

Major Credits: 52

Total Credits: 144

Last modified: 3/6/97

MECHANICAL ENGINEERING MAJOR

CLASS OF 2000

Major Electives:

These have been grouped into areas of concentration. A major may take electives in a particular area of interest or may choose a group of electives in any combination from across the groups.

Thermal Track:

EM443	Energy Conversion	3-0-3
EM446	HVAC* - Design and Analysis	3-0-3
EM450	Compressible Flow & Turbomachinery	3-0-3
EM461	Engines: Design and Analysis	2-2-3
EN362	Reactor Physics I	3-0-3
EN463	Reactor Physics II	2-2-3

Materials Track:

EM453	Materials: Processes & Fabrication	3-0-3
EM454	Mechanical Behavior of Materials	3-0-3
EM456	Corrosion & Corrosion Prevention	2-2-3
EM458	Failure Analysis	3-0-3

Mechanical Track:

EM417	Intermediate Mechanics of Materials	3-0-3
EM423	Mechanical Vibrations	3-0-3
EM432	Computational Methods in Structural Mechanics	3-0-3
EM434	Advanced Mechanics of Materials	3-0-3

* HVAC = Heating, Ventilation, and Air Conditioning

Other 300-400 level electives in either the Division of Engineering and Weapons or the Division of Mathematics and Science may be substituted upon approval of the Department Chair.

Engineering design requirements for the major are satisfied through the sequence of four design courses EM371, EM375, EM472 and EM477. The strong design emphasis of these courses is supported by design experiences in EM217, EM313, EM320, EM324 and EM415, as well as elective courses.

Naval Architecture Major

The naval architecture major is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology. This major came into being as an engineering discipline because of a single unique and complex end-product, the ship. A special combination of knowledge and experience is needed to design and build a ship. Variety exists not only in the kinds of work (research, design, cost-estimation, fabrication, and management), but also in the types of craft involved - from sailboats to aircraft carriers, hydrofoil boats to catamarans, and submarines to surface-effect vehicles.

Naval architects use both art and engineering in designing ships. Armed with imagination and experience, they convert functional requirements into a suitable, cost-effective design. They analyze and select the best dimensions and hull form, calculate the power requirements, and estimate the weights of the principal components. They design and analyze the hull structure and decide on the location of military sub-systems, machinery spaces, habitability and support spaces, and tankage. Additionally, the ship must be subdivided into watertight compartments so that, if damaged, the chances of survival are maximized. Weighing and resolving the many conflicting requirements in the design of a ship are the creative and challenging responsibilities of the naval architect.

Naval architecture at the Naval Academy approaches these topics in a fully integrated program of classroom sessions, hands-on laboratory work, field trips, and the latest in computer-aided ship design and analysis techniques. A naval architecture design room, two towing tanks, a circulating water channel, and a static stability tank are some of the many facilities available to midshipmen majoring in naval architecture. A distinguished and innovative faculty complement these excellent facilities and contribute to making this an outstanding undergraduate engineering major. A bachelor of science in naval architecture is awarded.

Curriculum Requirements (in addition to the requirements of plebe year)

Professional: NE203, NL302, NL400, NN200, NS310, NS40X;

Mathematics: SM212, SM221;

Science: SP211, SP212;

Humanities: HH205, HH206 plus two electives including one at the 300/400 level;

Engineering: EE331, EE332, EM211, EM217, EM232, EM318, EM319, ES300, ES410;

Major: EN245A, EN342, EN353, EN358, EN380, EN455, EN471, EN476, plus two major electives.

Class of 2000 - Naval Architecture Engineering Major - ENA					
3/c Fall	3/c Spring	2/c Fall	2/c Spring	1/c Fall	1/c Spring
NN200 3-2-4 Navigation		NS310 1-2-2 Tactics	NL302 2-0-2 Leadership IIII		NS401/2/3/4 1-2-2 Junior Officer Practicum
SP211 3-2-4 General Physics I	SP212 3-2-4 General Physics II				NL400 2-0-2 Law for the Junior Officer
SM221 4-0-4 Calculus III with Vector Fields	SM212 4-0-4 Differential Equations		EE331 3-2-4 Electrical Engineering I	EE332 3-2-4 Electrical Engineering II	ES410 3-2-4 Control Systems
NE203 3-0-3 Ethics and Moral Reasoning	HUM/SS Elective 3-0-3			ES300 3-0-3 Naval Weapons Systems	
	HH205 3-0-3 Western Civilization I	HH206 3-0-3 Western Civilization II			HUM/SS Elective 3-0-3
EM211 3-0-3 Statics	EM232 3-0-3 Dynamics	EM318 3-0-3 Applied Fluid Mechanics	EM319 3-0-3 Engineering Thermodynamics		
		EM217 3-2-4 Strength of Materials			
	EN245 2-2-3 Principles of Ocean Systems Engineering	EN342 3-2-4 Ship Hydrostatics and Stability	EN353 3-2-4 Resistance and Propulsion	EN455 3-2-4 Seakeeping and Maneuvering	
		EN380 3-0-3 Naval Materials Science and Engineering	EN358 3-2-4 Ship Structures	EN471 2-2-3 Ship Design I	EN476 0-6-3 Ship Design II
				Major Elective 3-0-3	Major Elective 3-0-3
18	20	19	17	17	17

Major Credits: 50

Total Credits: 142

Last modified: 3/6/97

NAVAL ARCHITECTURE MAJOR

CLASS OF 2000

Required Courses:

EM211	Statics	3-0-3
EM217	Strength of Materials	3-2-4
EM232	Dynamics	3-0-3
EM318	Applied Fluid Dynamics	3-0-3
EM319	Engineering Thermodynamics	3-0-3
EN245	Principles of Ocean Systems Engineering	2-2-3
EN342	Ship Hydrostatics and Stability	3-2-4
EN353	Resistance and Propulsion	3-2-4
EN358	Ship Structures	3-2-4
EN380	Naval Materials Science and Engineering	3-0-3
EN455	Seakeeping and Maneuvering	3-2-4
EN471	Ship Design I	2-2-3
EN476	Ship Design II	0-6-3
ES410	Control Systems	3-2-4

Major Electives:

EN451	Analytical Applications in Ship Design	3-0-3
EN452	Structural Reliability	3-0-3
EN454	Ship Vibrations	3-0-3
EN456	Advanced Methods in Ship Design	3-0-3
EN457	Hydrofoil and Propeller Design	3-0-3
EN458	Advanced Marine Vehicles	2-2-3
EN478	Submarine Design Analysis	3-0-3

Other electives in the Divisions of Engineering and Weapons or Mathematics and Science may be allowed upon approval of the Department Chair.

Ocean Engineering Major

Ocean Engineering holds the key to the last frontier on earth, the ocean depths. While marine scientists provide us with a basic knowledge of the ocean environment, the ocean engineer enables us to use this environment more effectively. By blending the fundamentals of mathematics, physics, chemistry and oceanography with knowledge of the engineering sciences, including ocean materials and wave mechanics, the ocean engineer plans, designs and builds a variety of coastal, harbor, and offshore structures; unmanned underwater vehicles and diver-support equipment; underwater acoustic systems; ocean energy and other marine-related environmental systems. Multi-disciplinary in nature, ocean engineering will appeal to civil, electrical, environmental and mechanical engineers who wish to practice in the ocean realm.

The ocean engineering major is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology. The major offers an integrated program of study, using a balance between classroom theory, laboratory work and practical application providing midshipmen with the background to work effectively as ocean engineers. Laboratory experiments are conducted in the 120-foot and 380-foot wave and towing tanks and coastal engineering basin. These are equipped with electro-hydraulic wave-makers and instrumented with sophisticated sensors and on-line data acquisition and analysis equipment. A circulating water channel, hyperbaric test facility and an environmental chamber are also available. The Naval Academy's computer systems are used in solving design problems and preparing computer-aided designs. Supervising, directing and teaching this program is a team of professionals recognized for providing one of the finest undergraduate majors in ocean engineering available in the country. A bachelor of science in ocean engineering is awarded.

Curriculum Requirements (in addition to the requirements of plebe year)

Professional: NE203, NL302, NL400, NN200, NS310, NS40X;

Mathematics: SM212, SM221;

Science: SP211, SP212;

Humanities: HH205, HH206, and two electives including one at the 300/400 level;

Engineering: EE331, EE332, EM211, EM217, EM232, EM318 EM319, ES300, ES410;

Major: EN245, EN380, EN441, EN461, EN462, EN475, SO221, plus four major electives.

Class of 2000 - Ocean Engineering Major - EOE					
3/c Fall	3/c Spring	2/c Fall	2/c Spring	1/c Fall	1/c Spring
NN200 3-2-4 Navigation		NS310 1-2-2 Tactics	NL302 2-0-2 Leadership III		NS401/2/3/4 1-2-2 Junior Officer Practicum
SP211 3-2-4 General Physics I	SP212 3-2-4 General Physics II		ES300 3-0-3 Naval Weapons Systems		NL400 2-0-2 Law for the Junior Officer
SM221 4-0-4 Calculus III with Vector Fields	SM212 4-0-4 Differential Equations	EE331 3-2-4 Electrical Engineering I	EE332 3-2-4 Electrical Engineering II	ES410 3-2-4 Control Systems	
NE203 3-0-3 Ethics and Moral Reasoning					
	HH205 3-0-3 Western Civilization I	HH206 3-0-3 Western Civilization II	HUM/SS Elective 3-0-3		HUM/SS Elective 3-0-3
EM211 3-0-3 Statics	EM232 3-0-3 Dynamics	EM318 3-0-3 Applied Fluid Mechanics	EM319 3-0-3 Engineering Thermodynamics	3-0-3 Math/Science/ Engineering Elective	
		EM217 3-2-4 Strength of Materials			
	EN245 2-2-3 Principles of Ocean Systems Engineering	EN380 3-0-3 Naval Material Science and Engineering	EN441 3-0-3 Ocean Engineering Structures	EN475 3-2-4 Ocean Engineering Mechanics	3-0-3 Major Elective
	SO221 3-0-3 Introduction to Oceanography			EN461 2-2-3 Ocean Design I	EN462 1-4-3 Ocean Design II
				3-0-3 Major Elective	3-0-3 Major Elective
18	20	19	18	18	16

Major Credits: 50

Total Credits: 142

Last modified: 3/27/97

OCEAN ENGINEERING MAJOR

CLASS OF 2000

Required Courses:

EM211	Statics	3-0-3	EN245	Principles of Ocean Systems Engineering	2-2-3
EM217	Strength of Materials	3-2-4	EN380	Naval Materials Science and Engineering	3-0-3
EM232	Dynamics	3-0-3	EN441	Ocean Engineering Structures	3-0-3
EM319	Applied Engineering Thermodynamics	3-0-3	EN461	Ocean Systems Engineering Design I	3-0-3
EM324	Fluid Dynamics	3-2-4	EN475	Ocean Engineering Mechanics	3-2-4
	SO221	Introduction to Oceanography		3-0-3	

Additionally, EOE majors must select one* of the following two tracks:

I. Civil/Structural Engineering Track

Three electives must be chosen from the following track electives:

EN411	Ocean Environmental Engineering I	2-2-3
EN412	Ocean Environmental Engineering II	3-0-3
EN420	Coastal Engineering	2-2-3
EN440	Design of Foundations for Ocean Structures	3-0-3
EN450	Engineering Economic Analysis	3-0-3
EN452	Structural Reliability	3-0-3
EN479	Design of Floating Platforms	3-0-3
EN485/6	Special Topics	3-0-3
EN495/6	Independent Research	3-0-3

Two additional courses are required:

EN442	Ocean Engineering Structures II	2-2-3
EN462C	Ocean Systems Engineering Design II	1-4-3

II. Underwater Technology Track

Three electives must be chosen from the following track electives:

EN411	Ocean Environmental Engineering I	2-2-3
EN430	Underwater Work Systems	3-0-3
EN450	Engineering Economic Analysis	3-0-3
EN452	Structural Reliability	3-0-3
EN470	Life Support Systems	3-0-3
EN477	Undersea Power Systems	3-0-3
SP411	Underwater Acoustics and Sonar	3-0-3
EN485/6	Special Topics	3-0-3
EN495/6	Independent Research	3-0-3

Two additional courses are required:

EN361	Marine Power Systems	2-2-3
EN462U	Ocean Systems Engineering Design II	1-4-3

* In exceptional cases, EOE majors may be permitted by the Chair to select courses from both tracks.

Systems Engineering Major

Many modern products, from microwave ovens, stereos and automobiles to spacecraft, missiles and robots, are a complex system consisting of components from many engineering disciplines. The systems engineer seeks to combine and control the diverse components in order to meet specific design specifications.

The Naval Academy's systems engineering program, rated number one in the country for more than ten years, is accredited by the Accreditation Board for Engineering and Technology. It is an interdisciplinary major encompassing electronics, mechanics, automatic control, computers and simulation. An overall understanding of the analysis and design of complete engineering systems, including the interdisciplinary interfaces between systems, is the primary goal of the major. Systems engineering is particularly suited to those persons interested in the higher level interactions of engineering components rather than the detailed design of specific components. A bachelor of science in systems engineering is awarded.

Since most modern systems contain automatic control functions using digital control techniques, the core of the systems engineering major is the study of feedback control theory, with digital control as a major element. Surrounding this core is the interdisciplinary part of the major, with advanced courses in digital technology and microprocessors, computer interfacing and engineering, analog and digital communications, analog and digital simulation and robotics. As a part of the interdisciplinary concept, portions of the systems engineering major may be fulfilled with advanced courses from all other engineering disciplines as well as mathematics, physics and computer science.

A systems engineer is particularly well prepared to operate and maintain the most sophisticated systems found in today's Navy. Knowledge gained in the major is directly applicable to missile, gun, sensor, guidance and propulsion systems. The systems engineering major also provides an excellent foundation for postgraduate education in any engineering discipline.

Curriculum Requirements (in addition to the requirements of plebe year)

Professional: NE203, NL302, NL400, NN200, NS310, NS40X;

Mathematics: SM212, SM221, SM239, SM312;

Science: SP211, SP212;

Humanities: HH205, HH206 and two electives including one at the 300/400 level;

Engineering: EE331, EE332, EM211, EM232, EM318, EM319, ES300;

Major: ES202, ES301, ES302, ES307, ES308, ES401, ES402, plus five major electives.

Class of 2000 - Systems Engineering Major - ESE					
3/c Fall	3/c Spring	2/c Fall	2/c Spring	1/c Fall	1/c Spring
NN200 3-2-4 Navigation	NE203 3-0-3 Ethics and Moral Reasoning	NS310 1-2-2 Tactics	NL302 2-0-2 Leadership III		NS401/2/3/4 1-2-2 Junior Officer Practicum
SP211 3-2-4 General Physics I	SP212 3-2-4 General Physics II		ES300 3-0-3 Naval Weapons Systems		NL400 2-0-2 Law for the Junior Officer
SM221 4-0-4 Calculus III with Vector Fields	SM212 4-0-4 Differential Equations	EE331 3-2-4 Electrical Engineering I	EE332 3-2-4 Electrical Engineering II		
	HH205 3-0-3 Western Civilization I	HH206 3-0-3 Western Civilization II		3-0-3 HUM/SS Elective	3-0-3 HUM/SS Elective
EM211 3-0-3 Statics	EM232 3-0-3 Dynamics	SM314 4-0-4 Engineering Math IV	EM319 3-0-3 Engineering Thermodynamics	EM318 3-0-3 Applied Fluid Mechanics	
SI283 1-2-2 Programming for Engineers				*ES401 2-2-3 Advanced Control Systems	
	ES202 2-2-3 Intro Systems Engineering	ES301 2-2-3 Analog/Digital Computer Methods	*ES302 2-2-3 Applied Control Systems	3-0-3 Major Elective I	ES402 2-4-4 Systems Design
		ES307 3-0-3 Linear Control Systems I	ES308 3-0-3 Linear Control Systems II	3-0-3 Major Elective II	3-0-3 Major Elective IV
				3-0-3 Major Elective III	3-0-3 Major Elective V
17	20	19	18	18	17

* Satisfies core requirements.

Major Credits: 55

Total Credits: 143

Last modified: 3/20/97

SYSTEMS ENGINEERING MAJOR

CLASS OF 2000

MAJOR ELECTIVE I-V

Option 1 - Pick two sequences A, B, C, or D.

Option 2 - Pick one sequence A, B, C, or D
and another sequence E, F, G, H, I, or J.

A.	INFORMATION SYSTEMS SEQUENCE	
	ES421 Digital Information Systems and	2-2-3
	ES422 Analog Information Systems	2-2-3
B.	CONTROL SYSTEMS SEQUENCE	
	ES413 Digital Control Systems and	2-2-3
	ES418 Modern Control Systems	3-0-3
C.	COMPUTER ENGINEERING SEQUENCE	
	ES430 Intro. to Computer Engrg. and	2-2-3
	ES432 Microcomputers in Control Systems	2-2-3
D.	ROBOTICS ENGINEERING	
	ES450 Intro to Robotic Systems and	2-2-3
	ES452 Advanced Topics in Robotics	2-2-3
E.	ELECTRONICS ENGINEERING	
	EE341 Electronics I and	3-2-4
	EE342 Electronics II	3-2-4
F.	MECHANICAL DYNAMICS	
	EM217 Strength of Materials and	3-0-3
	EM423 Mechanical Vibrations	3-0-3

G.	NUCLEAR ENGINEERING	
	EN362 Reactor Physics I and	3-0-3
	EN468 Nuclear Energy Conversion	3-0-3
H.	AEROSPACE ENGINEERING	
	EA413 Stability and Control and	3-0-3
	EA304 Aerodynamics II or	3-0-3
	EA364 Spacecraft Attitude Dynamics and Control	3-0-3
I.	ASTRONAUTICS ENGINEERING	
	EA362 Astrodynamics I and	
	EA462 Astrodynamics II or	3-0-3
	EA364 Spacecraft Attitude Dynamics and Control	3-0-3

MAJOR ELECTIVE V

EE421	Energy Conversion
EE426	Electronic Instrumentation and Measurement
EM214	Materials Science
EN450	Engineering Economic Analysis
EN470	Life Support Systems
ES49X	Systems Engineering Research
SM261	Matrix Theory
SM271	Linear Programming
SP411	Underwater Acoustics and Sonar

Other courses may be used as a major elective only with approval of
Chair, Weapons and Systems Engineering Department.